Curve-Fitting Using *Microsoft® Excel*

To curve fit an under-damped second order function using *Microsoft® Excel* follow the steps outlined below

1. Insert the disk containing the ASCII data file into a disk drive.

2. From the **File** menu select **Open** (or select the icon from the toolbar).

3. Select **All Files** from the **List Files of Type** sub-menu. Open the file containing your data.

4. The text import wizard window will pop up. A segment of your data will appear in the preview window.

   - If a comma separates the data then the data is *comma delimited*. Select the **Delimited** option then press **Next** and deselect the tab box, and select the comma box, then press **Finish**.
   - If the data is separated by a space then it is *space delimited*. Select the **Fixed Width** option.

5. The data from the file now appears in columns *A* and *B*. Assume that the data in the file represented the step response of an under-damped second order system. This mimics the initial-value response exhibited by a cantilever beam displaced from equilibrium. The time dependent solution is given by:

$$y(t) = A * e^{B*t} * \sin(C * t + D) + E$$

where

A : amplitude (V)
B : decay (rad/sec); $B<0$
C : frequency (rad/sec)
D : phase (rad)
E : offset (V)

If we want to fit a curve to this data then we must be able to determine *A*, *B*, *C*, *D*, and *E*. If we have a good idea of what these values are we can put the values of these parameters in various cells, and then we let Microsoft Excel fit a curve to the data. Let's put our initial values of *A*, *B*, *C*, *D*, and *E* into cells **E2** through **E6**. This is done by just entering the parameter value in its corresponding cell (*A* goes into **E2** etc.)

6. Now in order to curve-fit, we need to enter the equation for $y(t)$ into Microsoft Excel. Since our parameters will be updated we need to refer to them using absolute cell reference notation. So the equation for $y(t)$ would be entered into (column **C**) as

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$$= \$E\$2 * EXP(\$E\$3 * A2) * \mathrm{SIN}(\$E\$4 * A2 + \$E\$5) + \$E\$6$$

(note that the values in column **A** represent time, the values in column **B** represent amplitude). Drag this cell formula down so that all amplitude values in column **B** have a corresponding column **C** value. The original values for **E2** through **E6** may have been: **E2** = 0.1, **E3** = -0.3, **E4** = 100, **E5** = 0, **E6** = 0. The values contained in column **C** now represent an approximation to the amplitude in column **B**. To curve-fit these results we will use least squares minimization.

7. In column **D** we enter the formula

$$= (B2 - C2)\wedge 2$$

to find the squares of the differences between the amplitude values. Again, drag this formula so that column **D** is the same length as column **B** and **C**. We want to find the sum of the squares, we will put this value in cell **E8**. To do this enter

$$= \mathrm{SUM}(D2 : D302)$$

into **E8** (enter your data range instead of D2:D302 used here for illustration).

8. To minimize cell **E8** we will go to the Tools menu and select Solver. In the *Solver Parameters* menu select $**E**$**8** as the target cell. Select *Min* from the *Equal to* option, then enter: $**E**$**2**, $**E**$**3**, $**E**$**4**, $**E**$**5**, $**E**$**6** in the *By Changing Cells* window. Then press the *Solve* button. This process will attempt to minimize the value in cell **E8** (i.e. the sum of the squared differences) by adjusting the initial values you put into cells **E2** through **E6** (i.e., the parameters *A*, *B*, *C*, *D*, *E* from the equation on the previous page).

9. The program will run until the convergence criteria or the number of iterations to be performed is met. The 'best fit' values will be stored in cells **E2** through **E6**.

The intent of this handout is only to let you know that curve-fitting arbitrary functions can be done using Microsoft Excel. The example given above is intended to get you familiar with this feature.

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